

*Torrefaction is a process that changes biomass resources into a feedstock suitable for conversion to biofuels or for direct energy production.*



## Advanced Torrefaction System

*INL equipment converts biomass by roasting it at high temperatures*

**B**ioenergy technologies can produce homegrown, price-competitive bio-power and generate electricity at energy plants that might otherwise shut down. However, biomass presents a number of challenges, including its low energy density, high moisture content, grinding performance, handling performance and irregular particle sizes.

One technology to address these challenges, torrefaction, converts biomass into a feedstock suitable for either direct energy production or conversion to biofuels. The process roasts raw biomass in the absence of oxygen. The resulting material has grinding and combustion characteristics

that are compatible with existing heat and power boilers without expensive infrastructure modifications.

### **Advanced Torrefaction System**

Idaho National Laboratory's advanced torrefaction system allows researchers and industry to torrefy resources such as wood chips, agriculture residues and municipal solid waste for lab- and pilot-scale testing. The system is capable of continuous feeding and can process 10 kg of biomass per hour at temperatures ranging from ambient to 270 C. The advanced torrefaction system is also versatile enough to incorporate third-party technology for testing and validation.

Located at the Department of Energy's Biomass Feedstock National User Facility (BFNUF), the pilot-scale torrefaction system is part of BFNUF's Process Development Unit (PDU), a full-size, fully integrated feedstock preprocessing system. The PDU allows for on-site drying, grinding, pelleting and packaging of torrefied feedstocks.

With the PDU's counterparts — the Characterization Laboratory and the Bioenergy Feedstock Library — the BFNUF is a world-class feedstock research and development facility designed to provide knowledge for industry partners during scale up and integration of biomass preprocessing facilities.

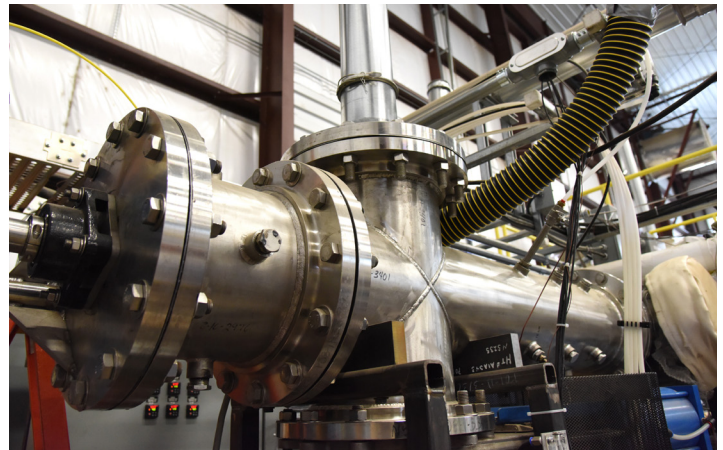
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**Torrefaction Benefits**

Torrefaction breaks down lignocellulosic matter without actual combustion, resulting in several benefits.

- **Improved Stability:**  
Torrefied feedstocks are less hydrophilic (water attracting) or even hydrophobic (water repelling), promoting energy retention during storage and transport.
- **Improved flowability:**  
Torrefied feedstocks tend to have improved feeding performance.
- **Improved energy value:**  
Torrefaction retains most of the resource's energy content while reducing moisture, volatile liquids and gases.
- **Reduced grinding energy:**  
Torrefied feedstocks require 50 to 80 percent less grinding energy.
- **Reduced variability:**  
Torrefied feedstocks pulverize more evenly and have more consistent moisture content.
- **Reduced off-gassing:**  
In storage, torrefied woody biomass emits lower levels of carbon monoxide, carbon



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dioxide and methane gases than untreated biomass.

**Opportunities**

While torrefaction results in a loss of 10 to 30 percent of the initial feedstock's energy content, INL researchers have tested technology that captures that lost energy in the form of effluent gases and chemicals. Those products can then be reintroduced into the system for specific purposes, such as heating the reactor or drying moist feedstocks, resulting in a process efficiency as high as 92 percent.

**Challenges**

Though torrefaction offers several potential benefits, significant challenges remain. Providing an inert atmosphere and processing/treating the evolved gases and liquids are costly. High-temperature torrefaction using reintroduced volatile gases and liquids can be difficult to control. Energy losses with high-temperature torrefaction are still considered too high, and torrefying biomass can produce fine particles that are potentially explosive.

INL researchers have the expertise to help industry overcome these barriers, so energy plants and biorefineries can use torrefaction to its full commercial potential.

*Torrefied material can produce biopower in coal-fired plants.*

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